

What To Do With CO₂ ?

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As part of America's "Coal Country", Indiana has a big stake in the debate over "What To Do with CO-2. Our Hoosier Homegrown Energy plan assigns Indiana coal—of which we have a 485 year supply at current production levels--- a pivotal role. However, coal's future is tied to our harvesting its energy value without paying an onerous environmental cost. "Clean Coal is not an oxymoron, it's the key to its future use.



What To Do With CO₂?

Indiana's Average CO₂ & Power Production from 1 Ton of Coal

1 Ton of Indiana Coal

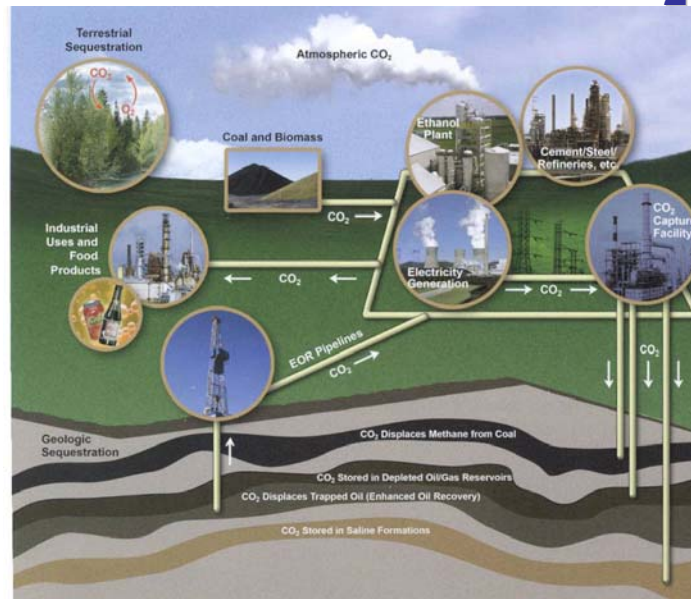


2.25 MWh electricity

2.26 Tons CO₂

➤ **1MWh of power ≈ 1 Ton of CO₂ produced**

What To Do With CO₂ ?



3

The new book "The World Without Us"--- or as the Wall Street Journal referred to it, "Wish You Weren't Here"---describes what the world would be without the human race on the planet. The author estimates it would take 100,000 years for the atmosphere to revert to pre-industrial levels if the human race were to disappear tomorrow. Since we don't plan on doing that, CO-2 will only grow as an issue. There are various ways to deal with CO-2, including continuing to not regulate it as a pollutant. However, not addressing the climate change issue politically seems unlikely.



What To Do With CO₂ ?

“Though skeptics may still grumble that the science isn’t settled, 84% of Americans think humans are contributing to climate change...”
“...78% say we should do something about it ‘right away’”

--Wall Street Journal

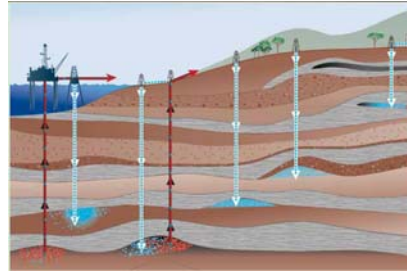
4

This issue of controlling CO-2 emissions to combat global warming has moved from Natural Science, through Sound Science to Political Science. Not all our political leaders have made this progression yet, including our Governor, and arguing against basing sound public policy upon sound science should be a tough sell. Nonetheless, Congress will debate this issue this fall and seems likely to legislate in the near future. The issue is moving from “whether” to “how”.

CO₂ Storage Duration

- injecting CO₂ into deep geological formations at carefully selected sites can store it underground for long periods of time.

- 99% or more of the injected CO₂ will be retained for 1000 years**



Source: "Carbon Dioxide Capture and Storage", Intergovernmental Panel on Climate Change, WMO, UNEP, 2005

Storage is both feasible and durable...



Location of some U.S. Natural Gas Storage Sites

- Underground natural gas storage projects offer experience relevant to CO₂ storage (operated successfully for almost 100 years).
- Majority of gas storage projects are in depleted oil & gas reservoirs & saline formations



Factors critical to the success of site: permeability, thickness, extent of storage reservoir, tightness of cap rock, geological structure, lithology

Sources: "Carbon Dioxide Capture and Storage", Intergovernmental Panel on Climate Change, WMO, UNEP, 2005

6

Our long Natural Gas storage experience should encourage us.



Indiana's CO₂ Storage

"The majority of estimates support the contention that sufficient capacity exists to store many 100's to many 1000's of GTons CO₂, but this range is too large to inform sensible policy." (MIT study)

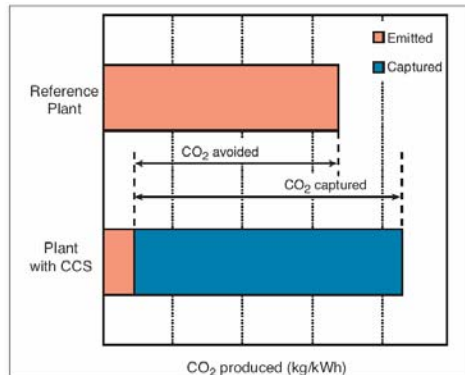
Initial estimates from the Indiana Geological Survey indicate that there are 38.0 BTons of CO₂ storage capacity under Indiana's Mt Simon Sandstone & 7.8 BTons under the New Albany Shale

7

Indiana is blessed with geologic formations conducive to CO-2 storage. It has been a factor in our partnership with Illinois in the U.S. Department of Energy's "FutureGen" project, which will demonstrate CO-2 sequestration at a commercial scale.

CO₂ Capture & Storage from Power Plants

A power plant equipped with a CCS system would need:



- 10–40% more energy than a plant of equivalent output without CCS, of which most is for capture and compression.
- A power plant with CCS could reduce CO₂ emissions to the atmosphere by approximately 80–90% compared to a plant without CCS

Source: "Carbon Dioxide Capture and Storage", Intergovernmental Panel on Climate Change, WMO, UNEP, 2005

8

The technical issue remains, how to best do it. CO₂ Capture and Storage (CCS) from power plants is a **Bridging Technology** approach to meet tighter environmental laws.



Capture & Storage Economics

Carbon Capture & Storage = CCS

Cost of Electricity = COE

Percentage increases in COE with CCS:

Pulverized Coal Power Plant 44-90%
IGCC Power Plant 24-52%

<i>Cost of Electricity 2005 Estimates US\$/MWh</i>	Pulverized Coal Power Plant	Integrated Coal Gasification Combined Cycle Power Plant, IGCC
Without CCS	43-52	41-61
With CCS	62-99	51-93

Source: "Carbon Dioxide Capture and Storage", Intergovernmental Panel on Climate Change, WMO, UNEP, 2005

9

This chart clearly illustrates that CO-2 control will require us to "pay to play".

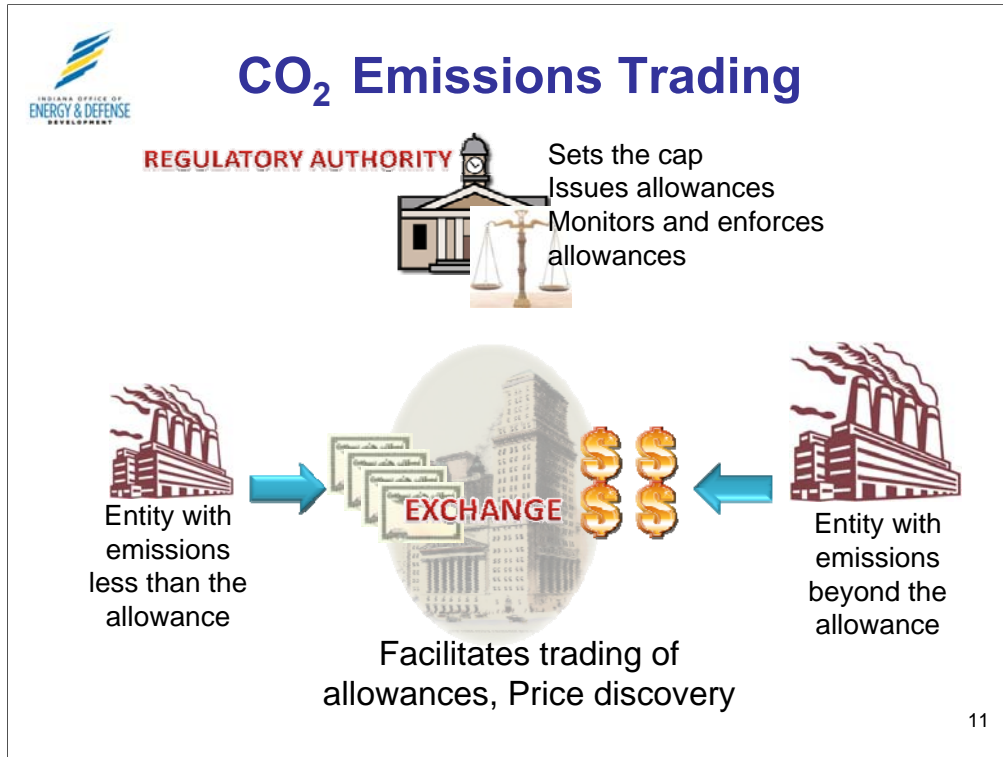
What's D.C. To Do With CO₂?

Carbon Tax

- Discourages Carbon-Intensive power generation
- Lets the Marketplace decide which technologies would be competitive
- No politically manipulated global commodity

10

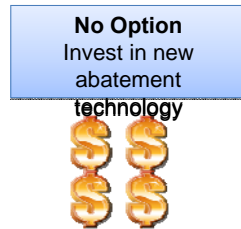
Let's consider the political options---other than continuing to ignore CO-2 as a pollutant needing control. Some favor a Carbon Tax to raise the price of injecting Carbon emissions into our environment. Proponents say it's the simplest, most straight forward way to discourage CO-2 generating technologies.



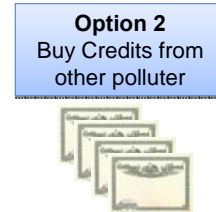
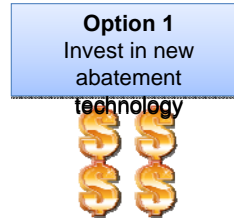
An alternative to a Carbon Tax, is a “Cap and Trade” system. This chart is a description of how it would work. Such a program should benefit from lessons learned from the earlier Cap and Trade system to control acid rain we enacted about twenty years ago.

CO₂ Comparison of Strategies

Command-and-control



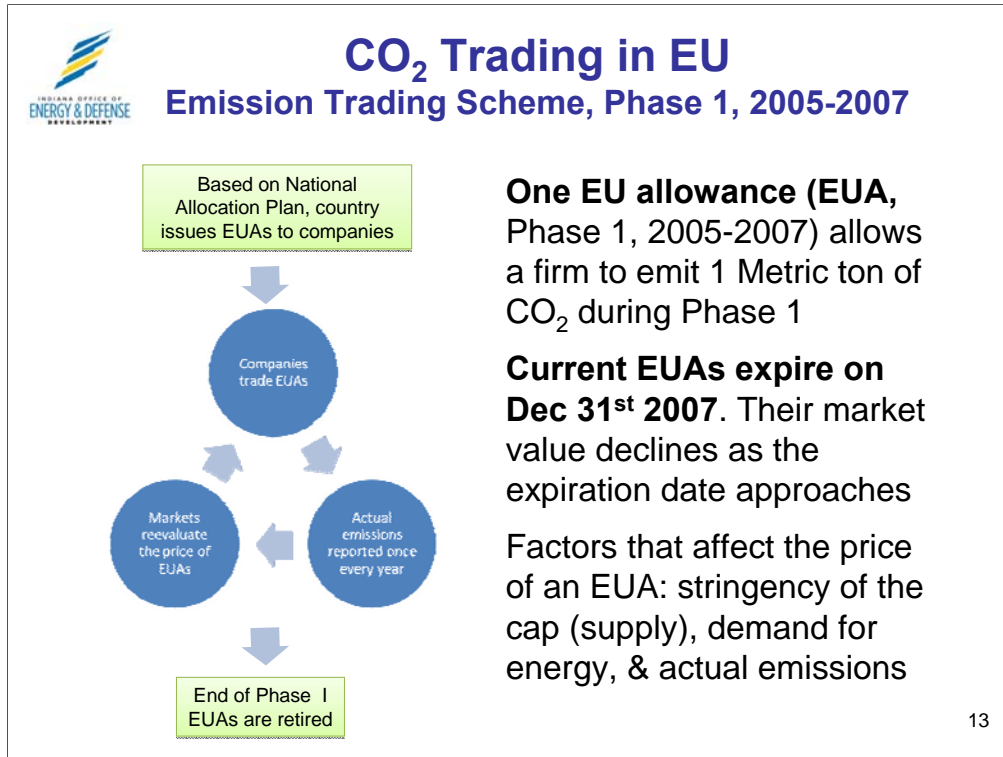
Emissions trading



Depending on the relative costs,
the firm is expected to choose the
least-cost option.

12

Trading offers power producers options that “Command and Control” schemes do not. Trading is seen by some as a better alternative to top-down “command-and-control” regime. A conventional trading approach is used to determine the market price of emissions for a given cap. “Command-and-control” also suffers from the problem that a regulator cannot know the economically feasible cap as well as a marketplace can determine it.



A “Cap and Trade” system is already underway in Europe. I will join the Chairman of the Indiana Senate Environment Committee and other officials from Midwestern States in Europe this fall to meet with our counterparts. We’re scheduled to tour some of their “Clean Coal” facilities with Carbon Capture and Storage and discuss their CO-2 trading program.



CO₂ Trading Lessons for the U.S.

- Credible regulatory authority is essential
- Centralized authority to set a cap at the national level
- Frequent appraisals on actual emissions to avoid extreme price fluctuations (as it was in Europe)
- Banking of contracts should be allowed to ensure continuity (EU-ETS, Phase II has this provision)
- Longer time horizon may provide greater incentive to invest in capital intensive long-term technologies

14

Both the earlier American and current European emissions trading programs offer some guidance for the future.



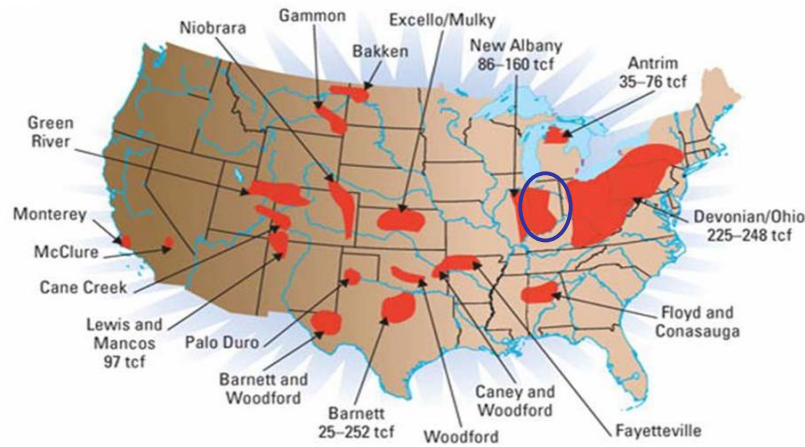
What To Do With CO₂?

How might CO₂ be employed as a useful and economically valuable by-product from power plants? This is the really **long-term question** of most value

15

I call this the “When Life Gives You (coal states) Lemons (Carbon control), Make Lemonade” slide.

CO₂ for Extracting Shale Gas



There are enormous amounts of shale gas in Indiana.
How economically can CO₂ be used to extract shale gas?

Source: Baseline Oil & Gas, Inc.

16

This is a national opportunity that includes Indiana.

Natural Gas Opportunity From Indiana Shale formations



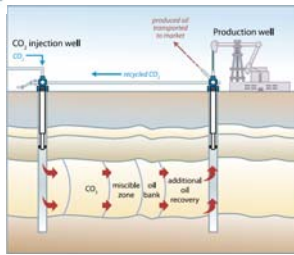
- Indiana could again be an important natural gas producer if we tap our substantial gas reserves trapped in and beneath Southwest Indiana Shale formations.
- CO₂ injection into shale formations has been successfully done in Michigan, Texas and elsewhere. could help.

17

The National Petroleum Council estimates 86 tcf of gas under New Albany Shale---that's over 80 years of Indiana gas consumption at current levels.



CO₂ Storage & Enhanced Oil Recovery



Small amounts of CO₂ dissolve in the oil, increasing the bulk volume & decreasing the viscosity, so facilitating flow



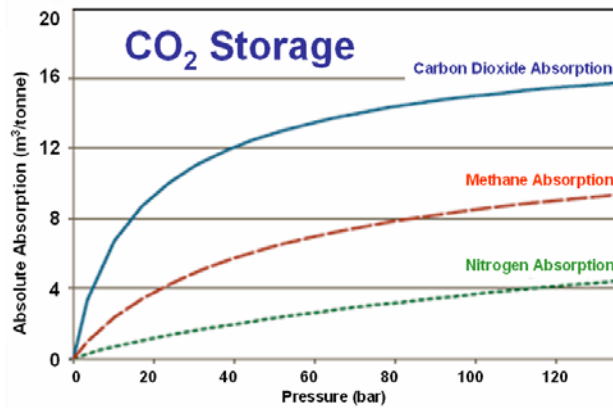
Average of 13% of the original oil in place, OOIP, is produced from **Enhanced Oil Recovery (EOR)**

Sources: "Carbon Dioxide Capture and Storage", Intergovernmental Panel on Climate Change, WMO, UNEP, 2005

18

Similarly, Enhanced Oil Recovery (EOR) has used injection techniques to increase petroleum production from "played out" oil fields for many years.

Enhanced Coal Bed Methane



Coal has very large number of micro pores & can absorb many gases, the most common among them being methane. Absorption refers to binding of gaseous or liquids to solid surfaces

One ton of Coal may contain up to 25 m³ of methane. CO₂ has higher affinity to coal than methane. This property is exploited to extract methane from coal seams by injecting CO₂

Source: IPCC, 2005: Special Report on Carbon Dioxide Capture and Storage, Special Report of the Intergovernmental Panel on Climate Change [Metz, Bert, Davidson, Ogunlade, de Coninck, Heleen, Loos, Manuela, and Meyer, Leo (Eds.)].

19

Natural gas—CH₄ or methane— can also be produced from coal beds through CO₂ injection.



Summary



New CO₂ Controls Likely

- Will make power more expensive
- Indiana has favorable geology for Carbon Capture & Storage
- Washington DC considering both trading schemes (as in European Union) and Carbon Tax
- Future coal use to be determined by ease/expense of future pollution controls
 - Projections that 85% of future incremental CO₂ emissions will come from developing nations like India and China will increase pressure on U.S. to control its CO₂

20

Summary



Using Captured CO₂ could benefit Indiana from:

- Using favorable geology to store CO₂ (eg FutureGen)
- Enhancing Natural Gas production from New Albany Shale
- Extracting methane (natural gas) from coal beds
- Enabling greater future coal production through amelioration of environmental concerns

What To Do With CO₂ ?

Resources

Indiana Office of Energy & Defense
Development

www.energy.IN.gov

Center for Coal Technology Research

<http://www.purdue.edu/dp/energy/CCTR/>

Indiana Geological Survey

<http://igs.indiana.edu/>



I recommend both our own Energy.IN.gov Web site to learn more about CO-2 control, as well as both the Indiana Geological Survey and our Center for Coal Technology Research (CCTR) at Purdue.

JOHN WAYNE CLARK



John W. Clark is a Senior Advisor to the Governor of Indiana, Director of the state's Office of Energy and Defense Development (OED), Chairman of the Interagency Council on Energy (ICE), and Chair of the Northwest Indiana Regional Development Authority (RDA).

Clark joined the Daniels' Administration following his retirement from over thirty years experience dealing with energy, environmental and economic growth issues in both government and industry. He served as Senior Vice President of CMS Energy (NYSE) and its principal subsidiary, Consumers Energy, for over sixteen years responsible for all corporate, public and governmental affairs including economic and community development activities in over twenty U.S. states and foreign countries.

Before joining the energy industry, Clark was Assistant Director for Congressional Affairs of the U.S. Energy Research and Development Administration, the U.S. Department of Energy (DOE), and U.S. Environmental Protection Agency (EPA).